TRIECA 2019 CONFERENCE

Thank you to our sponsors:

www.trieca.com

GOLD SPONSORS

AECOM

Credit Valley Conservation
inspired by nature

Stantec

AQUATECH

armtec
CANADACULVERT

CIVICA
Water Management Solutions

J. Lipani
TURF

CROZIER
CONSULTING ENGINEERS

terrafix
geosynthetics inc.

UNILOCK
DESIGNED TO CONNECT.

GEMS

Hydro International

R&M
CONSTRUCTION

filtrexx
CANADA
LAND IMPROVEMENT SYSTEMS
let nature do it.

Profile
Solutions for your Environment

Lake Simcoe Region
conservation authority

York Region

MEDIA SPONSORS

Environmental Science & Engineering
MAGAZINE

WATER CANADA

PRINT SPONSOR

WARREN'S
WATERLESS PRINTING INC.

HOSTS

CAN-IECA
CANADIAN CHAPTER

Toronto and Region
Conservation
Authority

Accounting for Carbon in Stormwater Management: The Carbon Storm Model and Potential Applications




Carbon Storm Inc.

5 | SMOOTH STONES RESTORATION INC.

Urban landscapes and embedded stormwater management systems have ecological benefits and costs

Carbon footprint of urban landscapes and stormwater management systems: potential questions of interest

1. Do “green” stormwater infrastructure provide carbon benefit over “gray”?
2. Can “green” stormwater infrastructure can be considered “carbon neutral?”
3. How large is the contribution of maintenance to overall carbon footprint?

What is Carbon Storm?

Tool with which to calculate the **carbon footprint** of urban landscape features and stormwater management practices

Developed with partners at North Carolina State University

- LeShawn Fernando, Carbon Storm Inc. founder
- Bill Hunt, Biological & Agricultural Engineering department

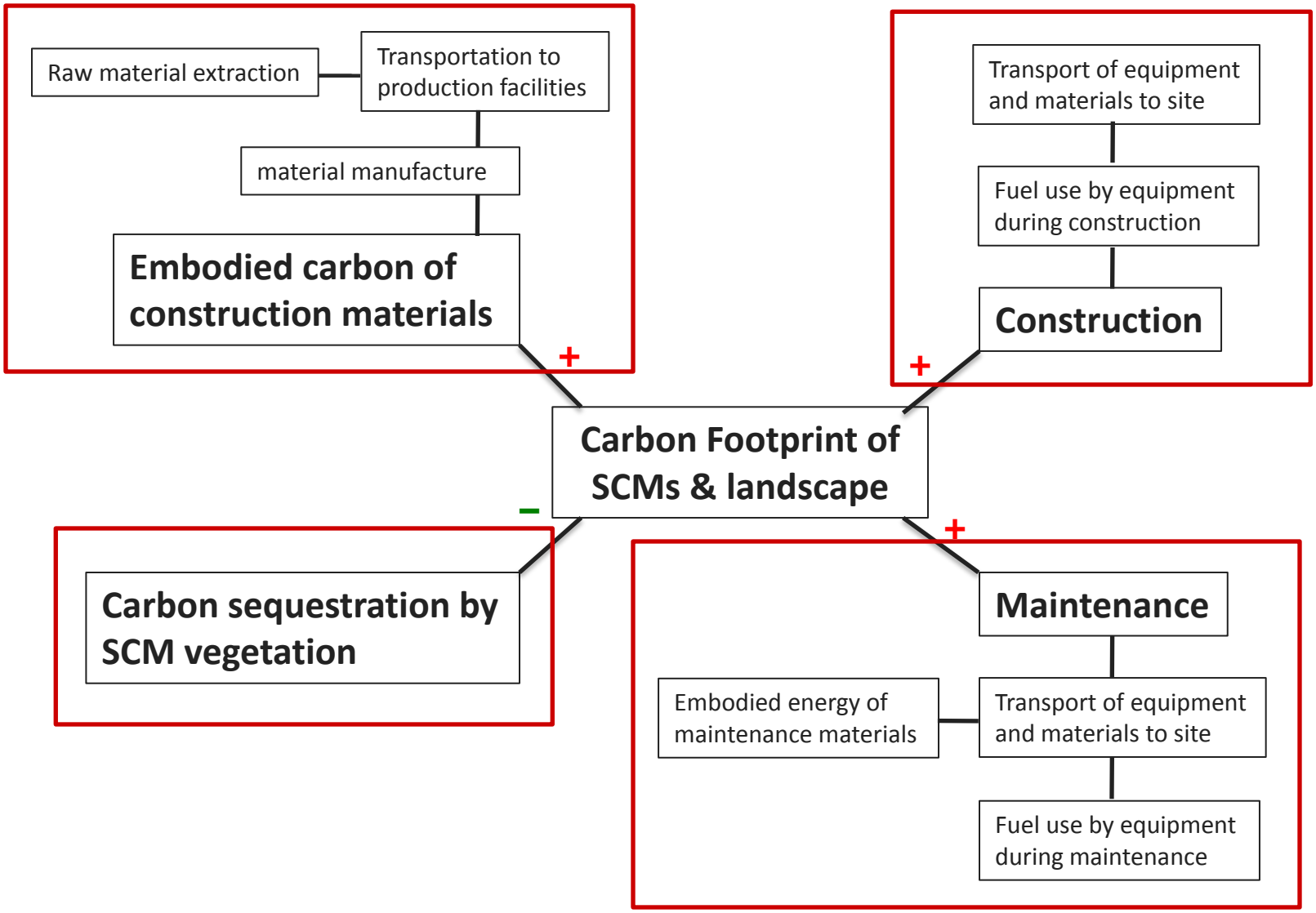
Carbon Storm Inc.

Presentation objectives

1. Provide overview of the Carbon Storm model
2. Compare carbon footprint of stormwater management systems and life cycle phases
3. Demonstrate potential uses of the model

Objective 1: Model overview – conceptual framework

C Footprint = Embodied C + Construction + (Maintenance – Sequestration) x time



Objective 1: model data sources

Life-cycle of urban landscape & SCMs: Embodied carbon of materials

kg $CO_{2\text{-eq}}$ kg^{-1} material

Extraction (photo credit: US EPA)

Manufacture (photo credit: US EPA)

Product

Data sources: Life Cycle Analysis Database (NREL); Inventory of Carbon and Energy Database (Jones and Hammond 2011); Ecoinvent Database (Swiss Centre for Life Cycle Inventories); individual studies

Objective 1: model data sources

Life-cycle of urban landscape & SCMs: Construction & maintenance emissions

On-road vehicle travel

- EPA MOBILE6.3
- $C_{emission}$ = fuel economy x C_{fuel}
- kg $CO_{2\text{-}eq}$ km^{-1}

Off-road equipment operation

- EPA NONROAD model
- $C_{emission}$ = BSFC x hp_{avg} x Load Factor x C_{fuel} x ρ_{fuel}
- kg $CO_{2\text{-}eq}$ hr^{-1}

Pond construction

(photo credit NCSU BAE)

Objective 1: model data sources

Life-cycle of urban landscape & SCMs: Vegetative carbon sequestration

Vegetation type	Sequestration rate ($g\ C\ m^{-2}$)
Trees (hardwood, softwood)	$0.4t^{1.82}$ (hardwood) $0.16t^2 - 0.46t + 2.2$ (softwood)
Wood Mulch (decomposition)	$1.5\ln(t) + 1.1$
Grass	$50t$ (fully watered) $28t$ (water limited)
Herbaceous – wetland (CSWs, littoral pond fringe)	$100t$ (Humid climates) $150t$ (Continental climates)
Sedums (green roof)	$190t$ for $t < 2$ yrs

Objective 1: model overview

Carbon Storm
Landscapes

User Name:

Carbon Storm *Landscapes*

Edit

New Run

Previous Runs

wetland+swale

Pave+Veg

Add a new landscape

To add a new landscape, please choose the type, enter a unique Landscape-tag, and click the 'add' button.

Landscape Type	Landscape Tag	
Permeable Pavement ▾	parking lot site	Add

- Permeable Pavement
- Standard Pavement
- Bioretention
- Planter Bed Trees
- Wetpond Wetland
- Conveyances
- Sand Filter
- Level Spreader Vegetated Filter Strips
- Green Roof
- Rain Water Harvesting System
- Landscaped Area

Edit

New Run

Previous Runs

wetland+swale

Pave+Veg

Part 1: Pavement Type

Pervious Concrete ▼

Part 2: Design Parameters

Parameter	Value	Unit
Pavement Area	10000	m^2
Gravel Bedding Thickness	20.0	cm
Void Area Percentage	20.0	%
Maintenance Period	20.0	yrs
Concrete Thickness	0.1	m

Part 3: Construction Transportation

1: Construction material transport

Material Type	Vehicle Type	Gas Type	Round Trip Distance to Site	Distance Unit
gravel	dump truck, 12 yd3 ▼	diesel ▼	100	km
Pervious Concrete	concrete mixing tru ▼	diesel ▼	100	km

2: Construction equipment transport

Vehicle Type	Number of Trips	Gas Type	Round Trip Distance to Site	Distance Unit
semi tractor trailer	2.0	diesel ▼	100	km

Part 4: Construction Site Preparation

Activity	Equipment Type
excavate and level	grader, 120 hp ▼
gravel placement	excavator, 120 hp ▼
compact subbase	roller, 120 hp ▼
concrete placement	concrete mixing tru ▼

Part 5: Maintenance

1: street sweeping

Vehicle Type	Frequency (times per year)	Round Trip Distance to Site	Distance Unit
street sweeper ▼	12.0	10	km

2: routine maintenance

Vehicle Type	Frequency (times per year)	Gas Type	Round Trip Distance to Site	Distance Unit
pick-up truck, class ▼	6.0	diesel ▼	10	km

Save Edits

Carbon Storm *Landscapes*

Edit

New Run

Previous Runs

wetland+swale

Pave+Veg

Part 1: Design Parameters

Parameter	Value	Unit
Grass Sod Area	1000.0	m2
Grass Seeded Area	0.0	m2
Maintenance Period	20.0	yrs
Trees/Shrubs	Yes	
Hardwood Trees Number	100.0	
Softwood Trees Number	100.0	
Shrubs Number	100.0	
Mechanical Tree Planting	No	

Part 2: Construction Transportation

1: Construction material transport

Material Type	Vehicle Type	Gas Type	Round Trip Distance to Site	Distance Unit
grass sod	semi tractor trailer, class hdv8a	diesel	20.0	km
grass seed	pick-up truck, class hdv4	diesel	0.0	km
trees shrubs	pick-up truck, class hdv4	diesel	20.0	km

2: Construction equipment transport

Number of Trips	Vehicle Type	Gas Type	Round Trip Distance to Site	Distance Unit
2.0	semi tractor trailer, class hdv8a	diesel	20.0	km

Part 3: Maintenance

Activity	Vehicle Type	Frequency (times per year)	Round Trip Distance to Site	Distance Unit
Crew Transport	pick-up truck, class hdv4	12.0	10.0	km
Mowing	mower, commercial/residential	12.0		
Irrigation (potable water)		20.0		
Fertilization		1.0		
Tree Pruning		0.2		

Part 4: Sequestration Parameters

Grass Type	Quantity	Unit
Turf Irrigated	100.0	%
Turf Unirrigated	0.0	%
Grass Native	0.0	%

Save Edits

Carbon Storm *Landscapes*

View | Edit | Delete

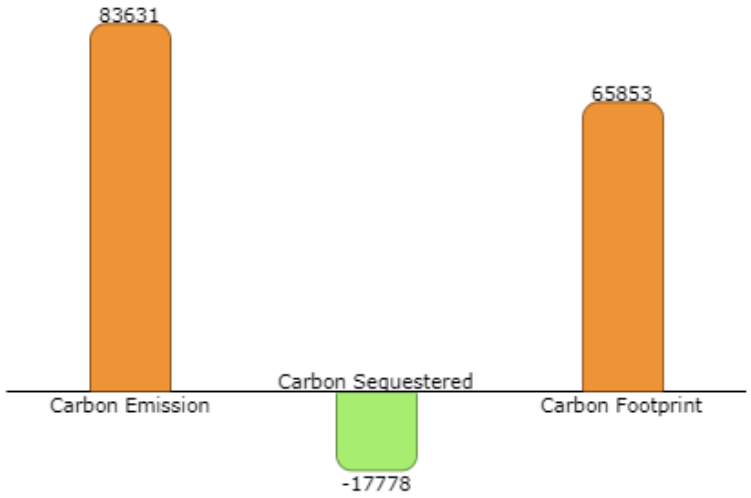
New Run

Previous Runs

- wetland+swale
- Pave+Veg
- permeable lot + trees

Carbon Footprint Results

Category	Carbon Footprint	Unit
Materials Embodied Carbon	58278	kg
Construction Generated Carbon	14960	kg
Maintenance Generated Carbon	520	kg per year
Sequestration Generated Carbon	-889	kg per year
Maintenance Period	20	year
Carbon Emission	83631	kg
Carbon Sequestered	-17778	kg
Carbon Footprint	65853	kg

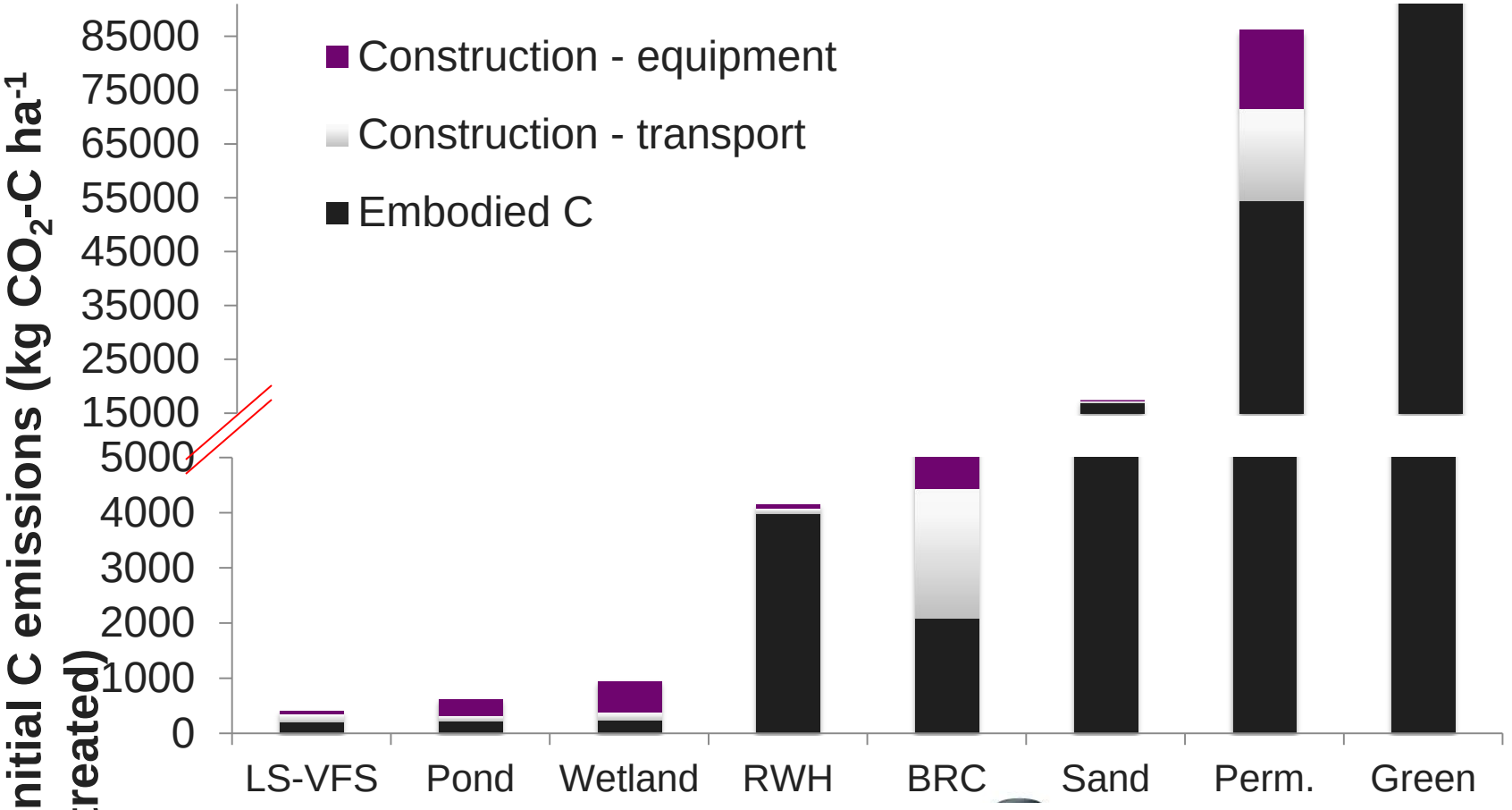


Carbon footprint of urban landscapes and stormwater management systems: potential questions of interest

1. How does the initial carbon footprint (embodied + construction carbon) compare across SCMs?
2. Can SCMs be considered “carbon neutral” through time?

Green Infrastructure	**Conventional**
Bioretention	Sand filter
Permeable pavement	Standard asphalt, concrete
Constructed wetland	Stormwater pond
Rainwater harvesting & reuse	Potable water use
Grass swale	Concrete pipes and channels
Grass filter strips	
Green roofs	

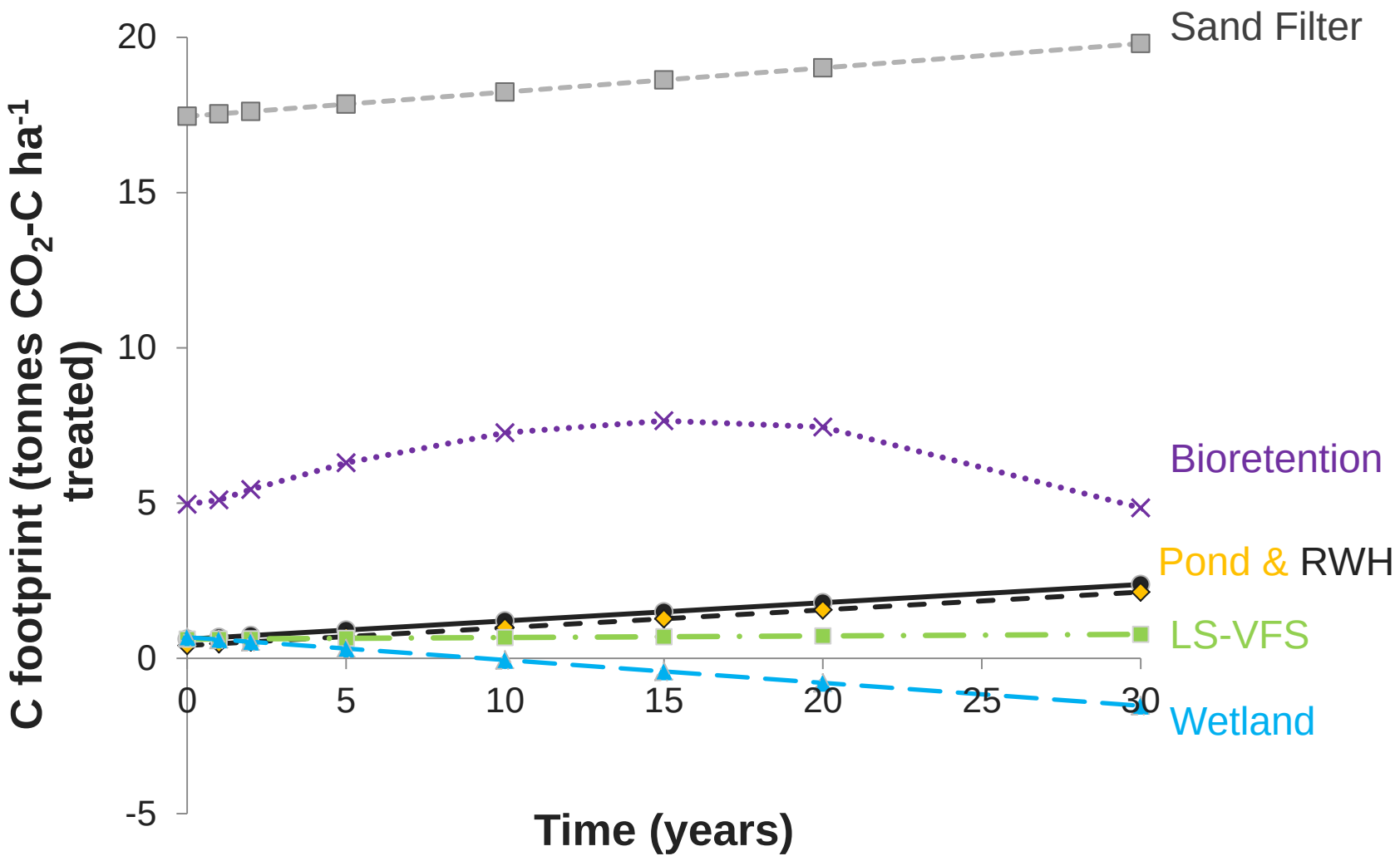
How does the initial C footprint compare among stormwater control measures?



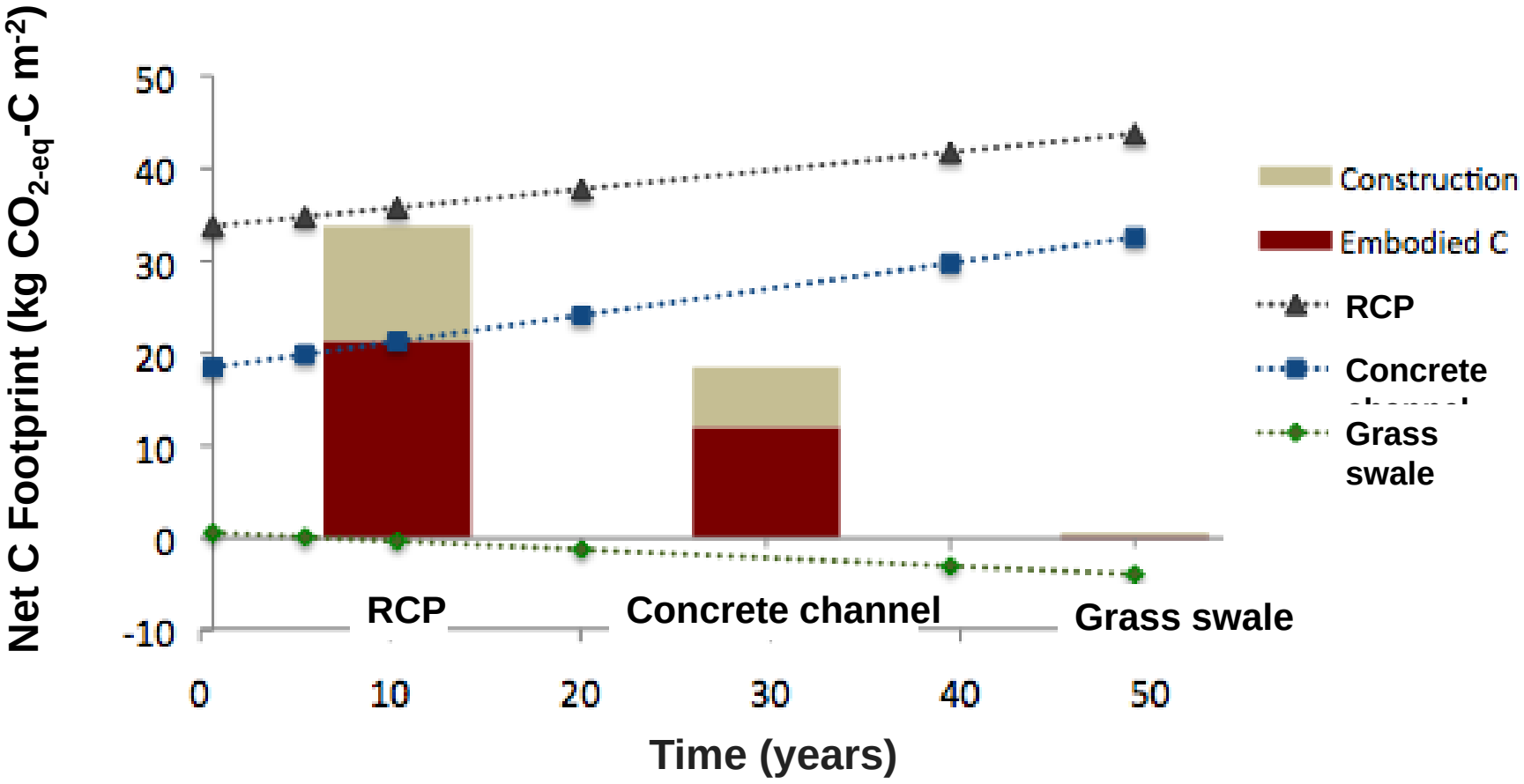
LS-VSF = level spreader-vegetated filter strip; RWH = rainwater harvesting; BRC = bioretention cell; Sand = sand filter; Perm = permeable pavement; Green = green roof

What is the influence of maintenance and carbon sequestration on C footprints through time?

What is the influence of maintenance and carbon sequestration on C footprints through time?



How do "green" versus "gray" stormwater conveyances compare?



Carbon Storm:
Possible Applications




Carbon Storm Inc.

5 | SMOOTH STONES
RESTORATION INC.

Background

- NCDOT
- Carbon footprint of Stormwater Control Measures (SCM)
- C can be considered in selection of SCM measures
- NCDOT is using it create a carbon bank

5 | SMOOTH STONES
RESTORATION INC.

Carbon Storm

- Carbon Footprint
  - Carbon used to manufacture, deliver, install and maintain SCM
  - SCMs include landscaping and so the model also accounts for carbon sequestration in vegetation
- Scaled from site to municipality
- Examples

5 | SMOOTH STONES
RESTORATION INC.

Municipal

- Carbon Footprint
- Focus on GHG emissions
- Carbon Storm lets you look at lots of other things
  - Landscape Maintenance
  - Stormwater Management Policy (Grey or Green)
  - C sequestration (e.g., Arbor Day, policy on street trees)
  - Carbon credits and banking

5 | SMOOTH STONES
RESTORATION INC.

Developers

- Help select stormwater management strategy for subdivision
  - More land for development = $
  - More land for C sequestration
  - Marketing Opportunity = $

5 | SMOOTH STONES
RESTORATION INC.

Site Planners

- Evolv 1 in Waterloo
- Green Building Council: 1st Zero C Building in Canada
- Green Building Council looks at building but not site
- Carbon Storm can be applied to the site
- Zero carbon site or possibly carbon credits

Summary

- NCDOT wanted to look at carbon footprint of SCM
- Carbon Storm can be used in many ways
  - Municipalities
  - Developers
  - Site Planners
- Others?
- Carbon Taxes/Carbon Credits?

Carbon Storm Inc.

5 SMOOTH STONES RESTORATION INC.

Thank you!

Trisha Moore, PhD
Assistant Professor
Biological and Agricultural Engineering
Kansas State University, 0039 Seaton Hall
Manhattan, KS 66506
Email: tlcmoore@ksu.edu
Tel.: 785.532.2911

Brad Fairley, MES
Director
5 Smooth Stones Restoration Inc.
227 Black Maple Court
Kitchener, ON N2P 2W8
Email: brad.fairley@fivessr.com
Tel.: 519.591.4200

TRIECA 2019 CONFERENCE

Thank you to our sponsors:

www.trieca.com

GOLD SPONSORS

AECOM

Credit Valley Conservation
inspired by nature

Stantec

AQUATECH

armtec
CANADACULVERT

CIVICA
Water Management Solutions

J. Lipani
TURF

CROZIER
CONSULTING ENGINEERS

terrafix
geosynthetics inc.

UNILOCK
DESIGNED TO CONNECT.

GEMS

Hydro International

R&M
CONSTRUCTION

filtrexx
CANADA
LAND IMPROVEMENT SYSTEMS
let nature do it.

Profile
Solutions for your Environment

Lake Simcoe Region
conservation authority

York Region

MEDIA SPONSORS

Environmental Science & Engineering
MAGAZINE

WATER CANADA

PRINT SPONSOR

WARREN'S
WATERLESS PRINTING INC.

HOSTS

CAN-IECA
CANADIAN CHAPTER

Toronto and Region
Conservation
Authority